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# A CUTTING TOOR FOR CUTTING SUPERHARD, HARD-TO-MACHIHE MATERIAL, ITS SHARPENING AND ITS USAGE

The invention relates to a modified ceramic cutting tool, its sharpening and its usage, particularly to a mechanical clamping or bonding insert teeth cutting tool being able to rough various superhard, hard-to-machine material blanks, to semi-finish and to fine finish workpieces and its sharpening as well its usage.

The disadvantages of high-purity alumina ceramic or alumina based composite ceramic ($Al_2O_3$ +15~30% TiC) is mainly its brittleness as said by Herbert S. Kalish in "Status Report: Cutting Tool Materials" <Metal Progress> No.11/1983. The alumina based ceramic tool though has many advantages get it has a poor resistance to impede and it is easy to collapse the edge so it has a very low constitutive ratio in materials of tool and in general this ratio is restricted in 1~5%. Cold-pressed or hot-pressed sintered Sialon ($Si_3N_4$-$Al_2O_3$) ceramics as described in "Silicon nitride inserts offer high cutting rates for cast iron <Cutting Tool Engineering> Vol.35/1983/No.1-2, it is unsuitable for processing steel workpieces and is rarely employed to process nonferrous metal workpieces. In processing certain metals such as cold hardening cast iron, quenched steel and nickel base alloy etc. hard-to-machine materials, there requires a cutting tool which has a good toughness, high hardness and high-temperature strength and can be abrasion resistant under high temperature and high stress (Japanese patent: No. 82145079, No. 84146983, No. 8469475; American patent: US-4388085, US-4286905; European patent: No. 95129), particularly a cutting tool which can achieve a super high-speed cutting as well as a high cutting rate process or a high precision and high finishness process, moreover a rough cutting process of various superhard, hard-to-machine material blanks.

An object of the invention is to provide a modified cutting tool mode by silicon nitride ($Si_3N_4$) base tough composite ceramics and its sharpen as well as its usage, which is able to rough and fine finish various superhard and hard-to-machine material and can expand the process ability of machines to achieve a high-speed or superhigh-speed cutting as well as a high cutting rate process or high precision and high finishness process, and which is especially able to pull-out rough cut various quenched steel and hard cast iron blanks.

The invention is accomplished through the following aspects: to form a hot-pressed or hot isostatic pressed or air pressed or nonpressarized smtered $Si_3N_4$ base tough composite ceramics into a prescribed geometry, after sharpening and polishing or dressing, the resulted cutting tool is set in a modified tooth bed and when it is used to process under an optimal cutting condition it can achieve a high-speed or a superhigh-speed cutting as well as a high cutting rate process or a high precision and high finishness process, especially a pull-out rough cutting of various quenched steel and hard cast iron blanks. The employment of the invention should conform to the following detailedly described implementing regulations:

The material of the blade in the cutting tool according to the invention is a high abrasion resistance $Si_3N_4$ base tough composite ceramics with a formulation of weight ratio: TiC 2-30%, TiN 0.3-5%, Co 0-9%, MgO 0-10%, $Y_2O_3$ 0-10%, $Al_2O_3$ 0-5%, AlN 0-5% and high parity fine $\alpha$-$Si_3N_4$ 100%.

The blade can be directly press molding or shaped by cutting. The geometry of the blade may be a (13×13)~(40×40) mm×mm square, a (5~15) ×(10~80) mm×mm rectangle, a (9.55×3.2×0.4) ~ (15.88×6.35×12)mm triangle, a $\phi$ 10~60mm circle with an external diameter $\phi$ 15~80mm and an internal diameter $\phi$ 6~30mm self-rotational blade, the thickness of the blade is 3~15mm (Fig.1). The cutting angles of the blade to be mounted on the shank are: forward angle ($\gamma$) 5°~14°, back angle ($\alpha$) 2°~8°, edge tilt angle ($\lambda$) 0°~14°, main deflection angle ($\phi$) 15°~75°, secondary deflection angle ($\varphi_1$)

0°~30°, negative chamfer of edge ($-\gamma \times a$) (-4°~-30°) × (0.1~0.5mm) and the arc radiush of the nose ≤ 0.3mm (Fig.3). The value of R may be larger than 0.3mm when there is a high feed quantity or a high finishness fine processing. If a chip breaking is required, it is possible to grind a (15×15) ~ (3×3) mm stepped or a r=1.5~3mm concave arc chip breaker on the front blade surface with a distance 1~3mm to the nose (Fig.5).

The shank for mounting the blade (Fig.2) is made from a high quality medium carbon steel of the moder number $35^{\#}$-$45^{\#}$ after annealing or modifying treatment bat without quenching. A mild bed of blade can be protected from an injury when the blade is pressed firmly. The feature of the insert teeth structure adopted by the invention is that the blade bed bottom and the lateral positioning surface are milled according to the practically required angles $\gamma$, $\alpha$, $\lambda$ and $\varphi$ and form angles $\delta_1$, $\delta_2$ and $\varepsilon$ with respect to the basal plane of the tool shank (Fig.4). The angle $\delta_1$ is dependent on the angles $\gamma'$ and $\alpha'$ of the auxiliary edge, the angle $\delta_2$ is dependent on angles $\gamma$, $\alpha$ and $\lambda$ and they are always selected as $\angle\delta_1=\angle-\gamma'=\angle\alpha$, $\angle\delta_2=\angle-\gamma=\angle\alpha=\angle-\lambda$ with the angle $\varepsilon$ being determined by the angle $\varphi$. The clamping plate of the blade should be rounded for pressing firmly on the end to protect from a biasing or an interference and the pressing point should be on the side approximating to the nose.

The blade is sharpened on a tool grinder or a special purpose tool grinder with an artificial diamond grinding wheel. The specification of the grinding wheel may be as follows: particle size $80^{\#}$-$180^{\#}$, concentration 75-100% resin bonding agent(s), bowl shape (Bw) or planar shape (p). The blade surface is lapped on a planar plate lapper with a diamond grinding paste adding an oil. The particle size of the grinding paste may be W5-W14 and the grinding agent adopts an oil of $10^{\#}$-$30^{\#}$. The material of the lapper may be high phosphorous cast iron or grey cast iron of grade I or II. The diamond oilstone may be substituted for the diamond grinding paste to grind and polish and

dress the blades used for rough processing or semi-finishness processing in site. The specification of the oilstone is of a concentration 6% and a particle size W10-W14. The oilstone should be added some oil in its operation.

During to sharpen the blade with the diamond grinding wheel, the grinding parameters are: the line speed v=1400-1800m/min, the longitudinal feeding being a low speed feeding through hand, the laterel feeding quantity being 0.01-0.03mm/dst (rough grinding) or ≤ 0.01mm/dst (fine grinding), before ending the grinding there being a requirement of polishing 2-5 times without cutting feed. The diamond grinding wheel once become blant may be dressed on the lapper with diamond grinding paste adding oil to remove the blunt diamond sands.

The cutting tool according to the invention has the following cutting parameters: in processing hard cast iron pieces of a hardness Hs 50-80 with a cutting speed (v=20-75m/min, a feed quantity f=0.1-2.6mm/r and a cutting depth a =0.2-5mm; in processing superhard cast iron pieces of a hardness Hs>80 with v=10-40m/min, f=0.1-1.2mm/r and a=0.1-3mm; in processing quenched steel of a hardness HRC 60-68 with v=20-60m/min, f=0.043-0.35mm/r and a=0.1-2mm; in processing common grey cast iron, semimalleable cast iron and nickel alloy cast iron pieces with v=150-1500m/min, f=0.1-2.6mm/r and a=0.1-5mm; and in processing nickel base alloy pieces. Then v=18-110m/min, f=0.1-0.45mm/r, a=0.2-2mm. The optimal cutting parameters should be selected dependent on the material, its hardness and process requirement of the workpieces to be processed in the above-motioned ranges. In processing quenched steel and cast iron pieces the cold lubricating liquid will not be used bat in cutting nickel base alloys and titanium base alloys or superhard cast iron the cold lubricating liquid can be adopted. The lubricating liquid must be supplied continuously, sufficiently and accurately and it may be a 5-15% emulsified liquid or a watersolube cutting fluid with a flow no less than 4.5-6lit/min to insure the cutting area to

have a sufficient and continuous cooling. The cutting test shows that a correctly cold lubrication may decrease an average abrasion value $V_B$ 6/7 on the back blade surface.

The cutting tool and its sharpening and usage according to the invention have passed a great many cutting tests, tests in the production site and application tests while a good effect is earned. In processing various hard cast iron – cold hard cast iron ($Hs \leq 90$), whle cast iron and super hard alloy abrasion resisting cast iron (HRC 62-64) etc., nickel base alloy, hard nickel sprayed coating and nickel alloy cast iron, nonferrous metal and its alloy, pyrolytic graphit, glass fibre laminated composite material and polypheny sulphone ether etc. new engineering plastics, the life of the $Si_3N_4$ base tough composite cermic blade according to the invention is 3-113 times the life of the $Al_2O_3$ composite ceramic blade and its material remove rate is 2-23 times that of the later. It can complish fine turning or fine willing hard iron metal pieces of a working toper ≤ 0.01mm/500mm with a finishness V7 and can also complish the fine turning of a $45^{\#}$ metal with ∇7-∇9 as well as the rough turning of the cast pieces with a $Hs \leq 82$. It can be used in the operations of turning, milling, planning, drilling, screwing, grooving and boring to achieve "substituting grinding by turning".

Embodiment 1: high speed turning grey cast iron of grade I, semi-malleable cast iron and nickel base sprayed coating.

In labratory, the cutting tool according to the invention can turn grad I grey cast iron and semimalleable cast iron pieces with a high cutting speed v=725m/min. The life of the tool is 11 times the life of the YG3 hard alloy tool. The cutting speed cannot be improved furtherly because of being restricted by the rotation speed of lathe and the diameter of the workpiece. Some factory employing the cutting tool according to the invention has achieved a high speed turning with a speed v=80-110m/min and the tool has been used steadily in production without collapsing the blade.

Embodiment 2: processing cold hard cast iron roll face.

Utilizing the $Si_3N_4$ base tough composite ceramic blade in five factories to carry out the cutting tests in site for $\phi(227\text{-}770) \times (800\text{-}3150)$mm cold hard cast iron roll(grind roll) (Hs 66-90), endless cast iron roll, a good effect is earned in rough turning cast pieces as well as in rough turning, semifinished turning and fine turning workpieces.

For blanks rough turning and workpieces rough turning, we adopt 20×20mm, thick 10mm $Si_3N_4$ base tough ceramic blade with its geometry shown as type (b) in Fig.1. In rough turning workpieces we also adopt the type (a). In semifinished turning workpieces, the 16×16 or 20×20mm blade of the type (a) in Fig.1 is used and the thickness of the blade is 6mm. On the 3A 64 grinder and the 2M 7025 tool grinder, the blade is sharpened by JR 120 S100 BW, 100×32.5×20, JR 180 S100 BW 100 × 32.5 × 20 artificial diamond grinding wheel. The grinding parameters are v=1433m/min, hand feed, lateral feed – 0.02mm/dst, grinding to ∇7-∇8 surface finishness, the blade for pull-out rough turning, rough turning and semifinished rolling being dressed with 6% concentration, W14 diamond oilstone, the blade for fine turning being on a grey cast iron planer plate with W5 diamond grinding paste adding $30^{\#}$ oil to be ground and polished to ∇9 for the forward blade surface and ∇10-∇11 for the back blade surface. For the geometry angles of the adopted tools, the geometry angles of the blade bed and the parameters of pull-out rough turning, rough turning, semifinished turning and fine turning are shown in the following table 1. The workpieces' material hardness, size and processing effect are shown in table 2.

Table 1

1 Parameter
2 step
3 geometric angle of tool
4 geometric angle of blade bed
5 cutting parameter
6 note
7 negative chamfer
8 pull-out rough turning
9 rough turning
10 semifinishness turning
11 fine turning
12 J48C symmetry
13 without cold lubricating liquid

Table 2

1 workpiece and effect
2 step
3 workpiece
4 processing effect
5 comparison of tool life when the back blade surface abrasion valae $V_{\beta}$=0.3mm
6 comparison of cutting rate and other
7 reducing machining time
8 processing taper (mm) surface finishness
9 pull-out rough turning
10 rough turning

11 semifinishness turning

12 fine turning

13 cold hard cast iron

14 5.8 times of YG3 blade, $Al_2O_3$ composite blade easily collapsed

15 4.54 times of YG3 blade

16 reducing 53% in comparison with YG3

17 cold bard cast iron

18 23 times of YG6 × blade

19 16.3 times of YG6 × blade

20 cold hard cast iron

21 3.48 times of B9 ceramic blade (Japan), 6.02 times of $Al_2O_3$-TiC (T6) blade, 7.98 times of $Al_2O_3$-$ZrO_2$ blade, 24.3 times of H1 (Sweden) blade

22 endless cast iron

23 15.36 times of $H_2O$ (Sweden) blade

24 cold hard cast iron

25 blade life 940 minutes, being 21 times of YG6 × blade

26 saving electricity 774kw.hr/piece

27 reducing 73.4% in comparison with YG6 × blade

28 cold hard cast iron

29 6.04 times of $H_2O$ blade

Embodiment 3: turning 20cr carburized quenched (HRC68) pin sleeve ports of a pushdozer.

Using the cutting tool according to the invention on CA 6140 lathe to turn a pushdozer's carburized quenched to HRC 68 pin sleeve with on excircle $\phi$78. The blade of type (a) in Fig.1 is adoped with geometric angles $\gamma$=-7°, $\alpha$=7°, $\lambda$=-7°, $\varphi$=45°, $\varphi_1$=15°, in addition, negative chamfer=-14°×0.1mm, R=0.2mm cutting parameters being v=38.2m/min, f=0.15mm/r, a=0.25mm and without cold lubricating liquid. To compare with

YT30 hard alloy blade, the life of cutting tool according to the invention is 66 times of the life of YT 30 blade.

Embodiment 4: selecting the optimal cutting speed and optimal feed quantity to minimize the abrasion of the cutting tool (to maximize the life of the cutting tool).

Workpiece to be processed: $\phi$125×180mm, the chemical composition is C, 2.35-2.94; Ni, 14.9-16.0; Cr, 1.41-2.16; Si, 1.71-2.50; Mn, 0.79-0.99; Cu, 7.22-7.33; P, 0.16-0.30. Its hardness HB is 160-200. It is formed through centrifugal casting.

To determine the optimal cutting parameters of the $Si_3N_4$ base tough composite ceramic blade in processing the workpiece with the aim that the overage abrasion value of an area B in the back blade surface of the tool is minimized, the optimal cutting speed Vo and the optimal feeding quantity are determined through a test design and cutting tests, meanwhile, based on examination of the interaction between v and f, the effect on $V_B$ given by the changes of v and f is to be decided.

Select the two factors v and f based on the workpiece and the rotation speed grade of the machine and give their levels in table 3.

Table 3

1 level

2 factor

3 cutting speed

4 feeding quantity

Select $L_8(4^1 \times 2^4)$ orthogonal test table. The cutting tool according to the invention ($\gamma$, -5°;$\alpha$, 5°; $\lambda$, -5°; $\varphi$, 45°; $\varphi_1$, 15°; negative chamfer, -10°×0.1mm; R, 0.1mm) is adopted on a CA6 140 lathe and the turning test by combinating

v and f has carried out 8 times according to a random sampling order number. When the total path L of cutting is constant for example L=870m. Determining the abrasion value $V_B$ of the back blade surface after each cutting the results are shown in table 4.

Table 4

1 parameter
2 level
3 order number
4 cutting test order number
5 abrasion value of the back blade surface, $V_B$=(mm)

Using the intuitive comparison method, calculate average abrasion values in corresponelence with $v_i$ and $f_j$.

$$\overline{V_1} = \frac{1}{2}(0.215 + 0.2) \approx 0.21,$$

$$\overline{V_2} = \frac{1}{2}(0.195 + 0.2) \approx 0.20,$$

$$\overline{V_3} = \frac{1}{2}(0.17 + 0.18) \approx 0.18,$$

$$\overline{V_4} = \frac{1}{2}(0.185 + 0.195) \approx 0.19,$$

$$\overline{f_1} = \frac{1}{4}(0.215 + 0.195 + 0.17 + 0.185) \approx 0.191,$$

$$\overline{f_2} = \frac{1}{4}(0.2 + 0.2 + 0.18 + 0.195) \approx 0.194.$$

The optimal value of the cutting speed is determined according to average values. When $V_3$=170m/min is selected, it corresponds to a minimum abrasion value of the back blade surface, therefore the $V_3$ is an optimal value. Similarly, the $f_1$ is an optimal value. The difference of the average $V_B$ values

in correspondence with $f_1$ and $f_2$ is small which shows a feeding quantity in the range of 0.08-0.30mm/r will not effect the $V_B$ significantly. Therefore, the cutting parameters may adopt v=170m/min, f=0.08mm/r (or 0.30mm/r).

After repeating the above test one time the interaction of v and f is examined through a variance analysis and the result is that the interaction is of no significance. The optimal cutting speed and the optimal feeding quantity are still 170/min and 0.08mm/r respectively (table 5).

Table 5

1 variance
2 quadratic sum
3 freedom
4 mean square
5 F ratio
6 critical value
7 significance
8 confidence

In order to verify the above method being able or unable to determine the optimal or the relatively optimal $v_0$ and $f_0$, an orthogonal cutting test is again carried out based on five levels namely v(54, 97, 166, 248, 407)m/min and f(0.08, 0.12, 0.16, 0.20, 0.24) designed by the table $L_L5(5)$ and the interaction of v and f is decided to be of no significance. In practice, v=166-248mm/min and f=0.08-0.16mm/r are adopted respectively as the range of optimal cutting speed and feeding quantity.

Embodiment 5: comparison of the cutting performance of several cutting tool.

Using the cutting tool according to the invention, the $Si_3N_4$-TiC-Co

system composite ceramic cutting tool, the T6 ($Al_2O_3$-TiC) ceramic cutting tool, the $Al_2O_3$-$ZrO_2$ ceramic cutting tool (Deutschland), the hand alloy 726, 610 and YN10 cutting tool on a CA6140 lathe to turn a hardness HRC 58-62 Cr WMn quenched workpiece of $\phi120\times260$mm, compare their cutting performance with the results shown in table 6.

Table 6

1 material of cutting tool

2 cutting performance

3 when $\gamma$=58m/min, f=0.1mm/r, a=0.25 and the total cutting path L=1373M the abrasion value $V_B$ (mm) of the back blade surface

4 the optimal cutting speed $v_0$ (m/min) at f=0.1mm/r and a=0.25mm

5 when v=58m/min, f=0.1mm/r, a=0.25mm and a constant $V_8$=0.30mm, the life T(min) of cutting tool

6 the invention utilized

7 unable to complish the processing

The practical result shows that the $Si_3N_4$ base tough composite ceramic blade of the invention has an average minimum abrasion value on its back blade surface when the total cutting path is fixed as L=1373m. For a fixed abrasion value $V_u$=0.30mm of the back blade surface, the life of cutting tool according to the invention reaches 310min which is 2.06 times of that of the $Si_3N_4$-TiC-Co ceramic blade, 7.06 times of that of the $Al_2O_3$-TiC system ceramic (T6) blade, 53.8 times of that of the 726 blade, 60 times of that of the 610 blade and 27.63 times of that of the YN 10 blade. In addition, the optimal cutting speed of the inventive blade v=58m/min which is higher than that of the other blades.

## What is claimed is:

1. A cutting tool being comprised of a blade (Fig.1) and a shank (Fig.2), characterized in that the blade material is the silicon nitride ($Si_3N_4$) base tough ceramics and is shaped in square rectangle, triangle, circle or other prescribed geometry and fixed on the shank by means of mechanic clamping or bonding, the shank being made from an unquenched tough material and milled based on a practical cutting anger (Fig.3) a blade mounting groove (Fig.4).

2. The cutting tool according to claim 1, characterized in that the blade material is processed by a hot-pressing or a hot is static pressing or an air-pressing or a nonpressurized sintering with a formulation of weight ratio: TiC 2-30%, TiN 0.3-5%, Co 0-9%, MgO 0-10%, $Y_2O_3$ 0-10%, $Al_2O_3$ 4-5%, AlN 0-5% and a high purity fine $\alpha$-$Si_3N_4$ 100%.

3. The cutting tool according to claim 1, characterized in that the geometry of the blade is a (13×13)~(40×40) mm×mm square, a (5~15)×(10~80) mm×mm rectangle, a (9.55×3.2×0.4)~(15.88×6.35×12)mm triangle, a $\phi$ 10~60mm circle with on external diameter $\phi$ 15~80mm and an internal diameter self-rotational blade, the thickness of the blade is 7~15mm (Fig.1), the cutting angles of the blade to be mounted on the shank being: the forward angle ($\gamma$) 5°~14°, the back angle ($\alpha$) 2°~8°, the edge tilt angle ($\lambda$) 0°~-14°, the main defection angle ($\varphi$) 15°~75°, the secondary deflection angle ($\varphi_1$) 0°~30°, the negative chamfer of edge (-4°~-30°)×(0.1~0.5mm) and the arc radius R of the nose $\leq$ 0.3mm (Fig.3), the value of R being possible larger than 0.3mm when there being a high feed quantity or a high finishness fine processing and if a chip breaking being required, it being able to grind a (15×15)~(3×3)mm stepped or a $\gamma$=1.5~3mm concave arc chip breaker on the front blade surface with a distance 1~3mm to the nose (Fig.5).

4. The cutting tool according to claims 1 and 3, characterized in that the shank is made from a high quality medium carbon steel of the model number $35^{\#}$-$45^{\#}$ after annealing or modifying treatment but without quenching, the blade mounting bed on the shank being required to be milled according to the geometric angle $\gamma$, $\alpha$, $\lambda$ and $\varphi$ as a positioning surface tilted with respect to the base surface of the shank (Fig.4).

5. A sharpening method of silicon nitride ($Si_3N_4$) base tough composite ceramic blade, characterized in that the blade is sharpened, ground and polished or dressed with an artificial diamond abrasive tool and abrasive.

6. The sharpening method according to claim 5, characterized that an artificial diamond grinding wheel is adapted with the following specification: particle size $80^{\#}$-$180^{\#}$, concentration 75-100%, resin bonding agent bowl shape or planer shape, the blade surface is lapped on a lapper made from cast iron materials with a diamond grinding paste adding an oil, the partied size of the paste being W5-W14 and the grinding agent is the $10^{\#}$-$30^{\#}$ oil, a diamond oil stone being able to be substituted for the diamond grinding poster to grind and polish and dress the blades used for rough processing or semi-finishness processing in site with the specification being a concentration 6% and a particle size W10-W14.

7. The sharpening method according to claim 5 or 6, characterized in that the grinding parameters are: the line speed v=1400-1800m/min, the longitudinal feeding being a low speed feeding through hand, the lateral feeding quantity being 0.01-0.03mm/dst (rough grinding) or $\leq$ 0.01mm/dst (fine grinding), before ending the grind there being a requirement of polishing 2-5 times without cutting feed and the diamond grinding wheel once become

blunt being able to be dressed on the lapper with diamond grinding paste adding oil to remove the bland diamond sands.

8. An usage of the cutting tool described in claims 1 and 5, characterized in that the cutting parameters are as follows: in processing hard cast iron pieces of a hardness $H_S$ 50-80 with a cutting speed v=20-75m/min, a feed quantity f=0.1-2.6mm/r and a cutting depth=0.2-5mm; in processing super-hard cast iron pieces of a hardness $H_S > 80$ with v=10-40m/min, f=0.1-1.2mm/r and a=0.1-3mm; in processing quenched steel of a hardness HRC 40-50 with v=20-60m/min, f=0.043-0.35mm/r and a=0.1-2mm; in processing common grey cast iron, semimalleable cast iron and nickel alloy cast iron pieces with v=150-1500m/min, f=0.1-2.6mm/r and a=0.1-5mm; and in processing nickel base alloy pieces then v=18-110m/min, f=0.1-0.45mm/r and a=0.2-2mm, and that the optimal cutting parameters should be selected dependent on the material and hardness of the workpieces to be processed in the above-mentioned range.

9. The usage of the cutting tool according to claim 8, characterized in that in processing quenched steel and cast iron pieces the cold lubricating liquid will not be used but in cutting nickel base alloys and titanium base alloys or superhard cast iron the cold lubricating liquid can be adopted, and that the lubricating liquid must be supplied continuously, sufficiently as well as accurately and it may be a 5-15% emulsified liquid or a watersoluble cutting fluid with a flow no less than 4.5-6lit/min.

# ABSTRACT

The invention provides a modified high abrasion resistant silicon nitride alloy tough composite ceramic cutting tool, its sharpening and its usage which can suitably rough and fine process various metal and nonmetal materials, engineering plastics and composite materials and is particularly able to pull-out rough process various superhard and hard-to-machine material blanks as well as semifinishness process and fine process workpieces. The high red hardness and long cutting life as well as steady chemistry cause the cutting tool to be able to achieve a high-speed cutting and a high material cutting rate process as well as a high working accuracy and surface finishness process, in addition, the invention can expand the technology ability of the present machines and earn a good economic efficiently. The cutting tests and the production application show the performance of the cutting tool according to the invention is superior to the hard alloy blades and the present ceramic cutting tools.